HALSTED, (W. S.)

The Effects of Adduction and Abduction on the Length of the Limb in Fractures of the Neck of the Femur.

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WILLIAM S. HALSTED, M. D.,

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THE EFFECTS OF ADDUCTION AND ABDUCTION ON THE LENGTH OF THE LIMB IN FRACTURES OF THE NECK OF THE FEMUR.*

Agreed though we all are that the pelvis should be horizontal when measurements to determine the relative lengths of the limbs are made from the anterior superior spinous processes of the ilia to the malleoli, very few indeed are familiar with the facts which make it necessary. The reply, that an obliquity of the pelvis causes an apparent difference in the relative lengths of the lower extremities, is true, but does not explain. It implies, to be sure, that one leg is abducted and the other adducted, and yet this of itself might be possible without leading to error by measurement.

Thus, in Fig. 1, let *rs* and *ls* represent the anterior superior spines of the ilia, *ra* and *la* the right and left acetabula, and *rm* and *lm* the right and left malleoli (external or internal). If, now, the pelvis be rotated on an antero-

* Read before the Medical Society of the County of New York, February 25, 1884.

posterior axis passing through the left acetabulum, *la*, the right malleolus, *rm*, becomes raised to *rm'*; the right leg is adducted and apparently shortened, and the left leg is

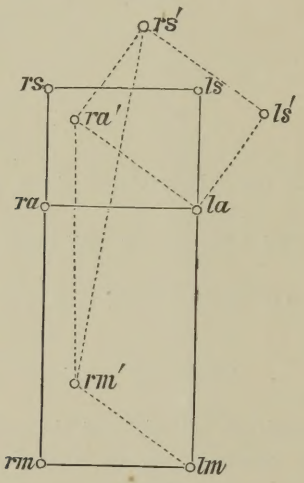

FIG. 1.

abducted. Nevertheless, the line *rs' rm'* = *ls' lm*, just as before the line *rs rm* = *ls lm* did, proving that, if our diagram be correct, measurements from spines to malleoli can determine accurately the relative lengths of the limbs, notwithstanding an obliquity of the pelvis.

But we know, from observation of the earlier stages of hip-joint disease, that, if the diseased limb be adducted and apparently shortened, it will measure longer than the healthy limb; and, conversely, that, if the diseased limb be abducted and apparently lengthened, it will be shorter by measurement than the sound limb.

This could not be the case if the spine, acetabulum, and malleolus of one side occupied the same perpendicular line

as represented in Fig. 1. We look, then, to the skeleton for an explanation, and find that the spines are farther apart than the acetabula are. In Fig. 2 this is illustrated. Here,

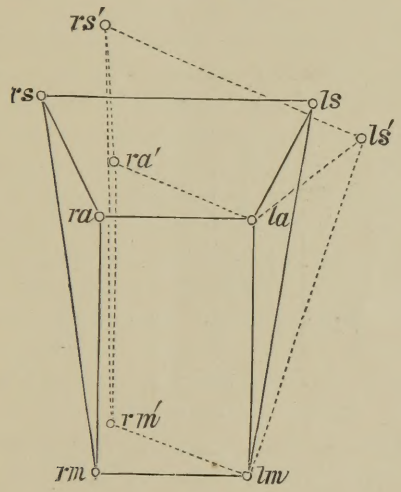

Fig. 2.

too, the line *rs rm* = *ls lm*, provided the line *rs ls* be parallel to the line *rm lm*, or, in other words, provided the pelvis be horizontal. When, however, it is rotated, as before, about an antero-posterior axis through the left acetabulum, *la*, the line *rs′ rm′* measures more than the line *ls′ lm*. Because, then, of the tilting of the pelvis, the abducted left leg measures less than the adducted right leg. Furthermore, the abducted left leg measures less than it did when straight, and the adducted right leg more than it did when straight, as a glance at Fig. 3 will suffice to show.

In this figure the obtuse-angled triangle *rs ra rm* has, for the sake of clearness, been separated from Fig. 2, and

now it is perfectly evident that when the angle *rs ra rm* is made less obtuse, as it would be by abducting the leg *ra rm*, the line *rs rm''* measures less than *rs rm*; that is to say, the

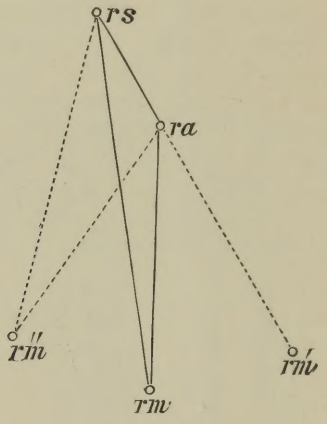

FIG. 3.

leg is shortened by measurement from spine to malleolus, and that adducting the leg until the spine *rs*, the acetabulum *ra*, and the malleolus *rm* occupy the same straight line, *rs ra rm'*, lengthens the leg by measurement. For in the one instance (in abduction) we measure one side *rs rm''*, and in the other (in adduction) *rs ra* + *ra rm* of the triangle. A. Nélaton recognized this triangle, and pictures it in his "Éléments de pathologie chirurgicale," tome ii, p. 833.

And, to quote Barwell,* Gädechens, in 1836, called attention to the fact "that when the ilium inclines to one side, its crista must approach the trochanter of the femur; thus, though the whole thigh may sink and appear longer, the measurement between any point of the crista ilii and of the thigh must be shorter than the other limb." I do not

* Barwell, "A Treatise on Diseases of the Joints," 1861, p. 304,

understand why he did not (if indeed he did not) draw the complementary conclusion that adduction, up to the extent to which we have already referred, must make the limb measure longer, unless, as is highly improbable, he believed that the spine, acetabulum, and malleolus were normally on the same perpendicular, in which case adduction would make the limb measure just so much shorter as abduction through the same number of degrees would. I say "highly improbable," because Gädechens speaks of a sinking, apparent lengthening, and measured shortening of the abducted thigh. Now, apparent lengthening with measured shortening of the abducted limb would, if the three points above mentioned were on the same perpendicular, only be possible provided the limbs were not approximated; and if Gädechens compared by measurement divergent limbs, irrespective of the angles which they formed with the pelvis, his results could not have been sufficiently constant to enable him to arrive at the conclusions which he did. To confirm, experimentally, that adduction produces lengthening by measurement from spine to malleolus, the writer has driven nails into cadavers at the points mentioned, and found that adduction may give measured lengthening from 2 to 8 mm., and abduction measured shortening from 2 to 4 cm., or thereabouts, in different cases.

Clinically, too, in fractures of the neck of the femur, adduction and abduction probably frequently occur, and to a considerable degree. To recognize these as factors in the deformity is essential for even an approximate estimation of the amount of real as distinguished from measured and apparent shortening. Its recognition is further of importance from the treatment standpoint.

If in fracture of the neck of the femur there be neither abduction nor adduction, the pelvis will be horizontal when the legs are parallel. In such a case the apparent shorten-

ing, real shortening, and measured shortening would be practically equal. Thus, in Fig. 4, the apparent shortening $= lm\ y$, the real shortening $= rt\ x$, and the measured shortening $= ls\ lm - rs\ rm$.

When, however, adduction is an element in the deformity, there will be apparent shortening, almost invariably real shortening, and possibly measured lengthening, provided the adduction be considerable and the real shortening not excessive.

This measured lengthening I have once observed in my wards at Bellevue Hospital, and had the opportunity to confirm the diagnosis at the autopsy. The case was reported recently at the surgical society, and the specimen of the fracture, which was intra-capsular, presented.

It is in this particular variety of fracture, when associated with adduction, that the diagnosis might be difficult,

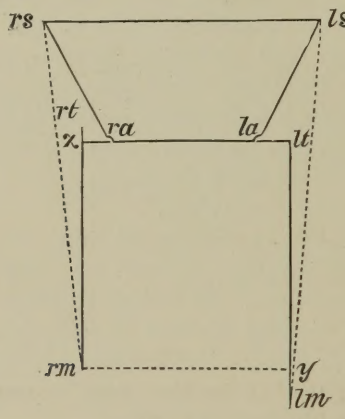

FIG. 4.

if not impossible, unless the special features of the case were recognized.

Lisfranc and Lallemand have each observed a case of fracture of the neck of the femur in which the broken limb was the longer.

Senn,* referring to these cases, says that "it is *impossible to conceive* in what manner the fracture could add to the length of the limb."

He was evidently unacquainted with the points upon which the writer is dwelling.

The recognition of the adduction is furthermore of importance because, if the limb be allowed to remain in this position, the patient will surely limp when he walks, not-

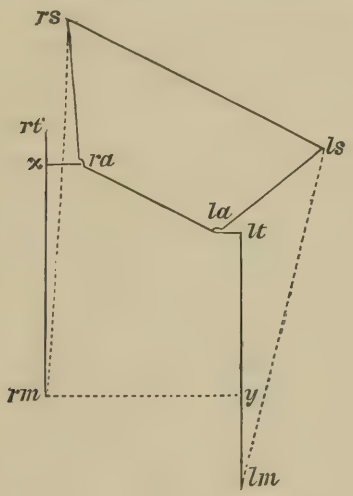

Fig. 5.

withstanding the fact that there may be measured lengthening and very little real shortening.

In Fig. 5 is outlined a fracture of the neck of the right

* "Fractures of the Neck of the Femur," N. Senn, "Transactions of the American Surg. Assoc.," vol. i, 1883.

femur, with adduction. The apparent shortening, *lm y*, is excessive, although the real shortening, *rt x*, is inconsiderable. The lengthening by measurement equals *rs rm — ls lm*.

Figs. 6 and 7 represent fractures of the neck of the right femur, with abduction. In 6 there is little abduction and great real shortening, and, consequently, apparent shortening. In 7, much abduction, little real shortening, and hence ap-

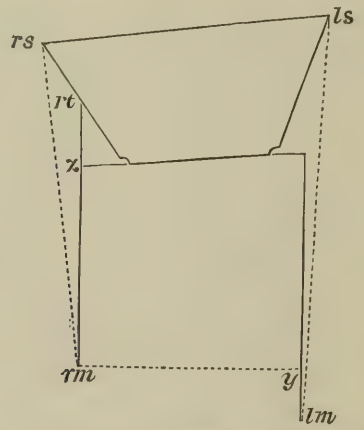

FIG. 6.—FRACTURE OF THE NECK OF THE RIGHT FEMUR, WITH SLIGHT ABDUCTION.

lm y, apparent shortening; *rt x* > *lm y*, real shortening; *ls lm*—*rs rm* > *rt x*, measured shortening.

parent lengthening. Although the measured shortening is greater in 7 (the case of apparent lengthening) than in 6, the patient in the case of apparent shortening (Fig. 6) would limp, and in the other might not. Apparent shortening, consequently, is undesirable, and should be overcome if possible. Thus it becomes evident that statistical tables designed to show how much measured shortening may exist without causing a limp, and how little measured shortening occurs in

many cases of fractures of the neck of the femur, are worthless unless the adduction and abduction which may have been present were recognized.

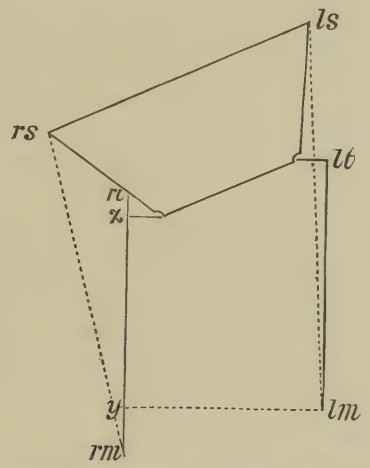

Fig. 7.—Fracture of the Neck of the Right Femur, with Abduction. *rm y*, apparent lengthening; *rt x*, real shortening; *ls lm—rs rm*, measured shortening.

König* believes that the amount of apparent lengthening or shortening equals the difference in level between the right and left anterior superior spines of the ilia. That this is not strictly accurate is shown in Fig. 8; for the line *rs z*, which represents the difference in the level of the spines, is longer than the line *y lm*, which represents the apparent lengthening. The line *ra x = y lm*, but, unfortunately, can not be accurately determined on the living subject. Bryant's line, for obvious reasons, is only to be relied upon when the pelvis is straight.

To determine, then, approximately, the amount of real

* "Lehrbuch der speciellen Chirurgie," vol. iii, p. 267,

shortening, it is best that the pelvis should be horizontal. For the sake of accuracy, a Volkmann's coxankylometer, or something equivalent, may be employed.

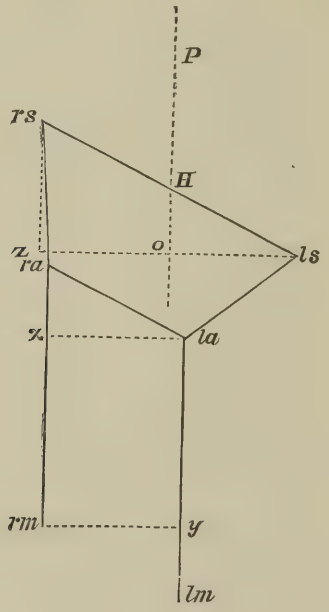

Fig. 8.

Or, if it be difficult to straighten the pelvis, one might make use of a procedure recommended by Giraud-Teulon. This consists in a geometrical device for determining the distance of either one of the condyles of the femur from the center of the cotyloid cavity. The middle point of a line drawn from the anterior superior spine of the ilium to the tuberosity of the ischium corresponds quite closely to the center of the acetabulum. If, then, a triangle be formed by

lines drawn between one of the condyles of the femur, the anterior superior spine of the ilium, and the tuberosity of the ischium, the length of a line let fall from the condyle selected (the apex of the triangle) to the middle of the base line (that drawn from spine to tuberosity) equals the distance from said condyle to the center of the cotyloid cavity, whatever may be the position of the pelvis or femur.

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